National Transportation Safety Board

SpaceShip Two: The Anatomy of a Commercial Space Accident

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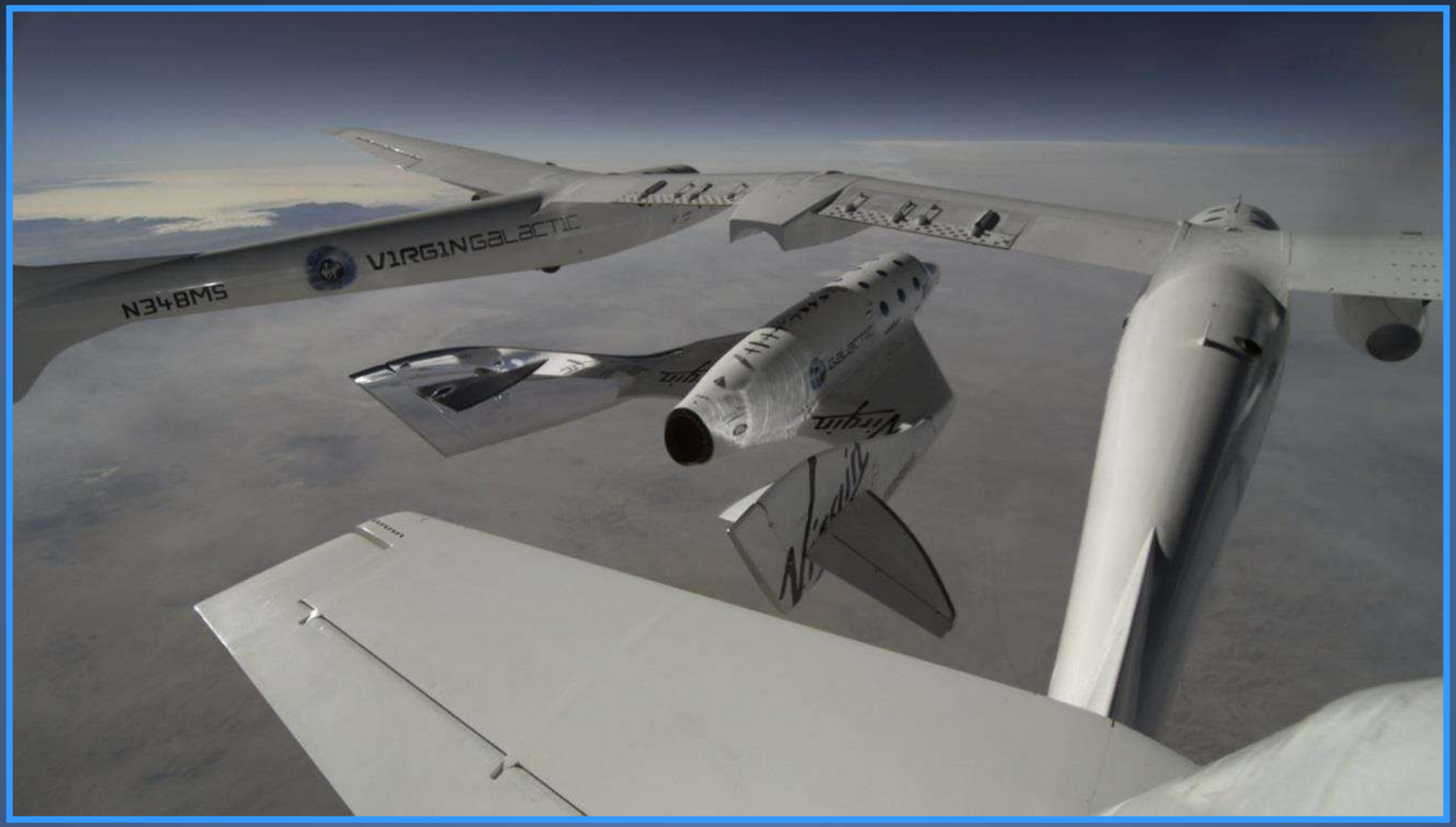
Presentation to Academie de L'Air et du L'Espace

In-Flight Breakup During Test Flight

October 31, 2014

NTSB


N348MS
N339SS
N348MS


N348MS
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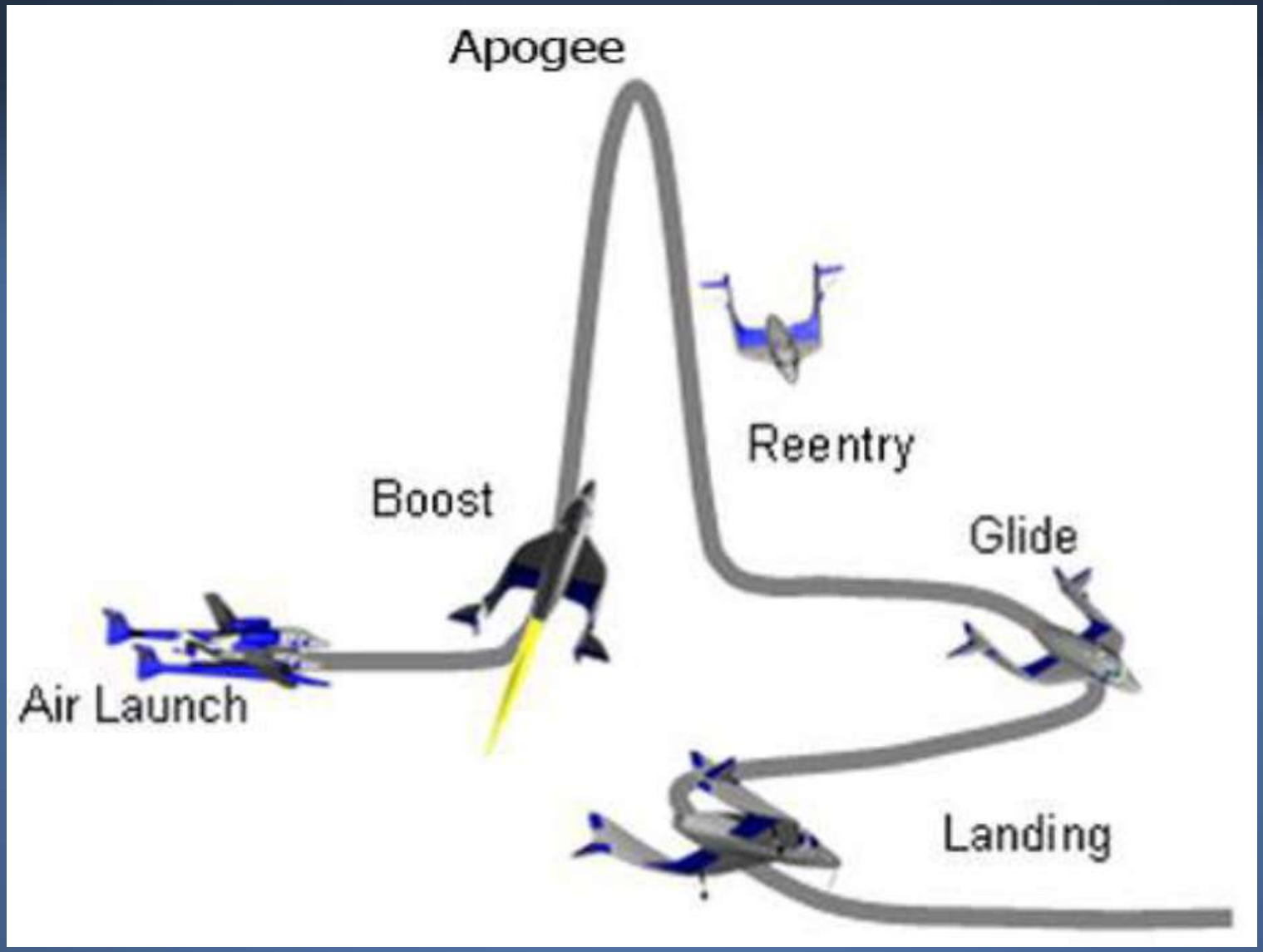
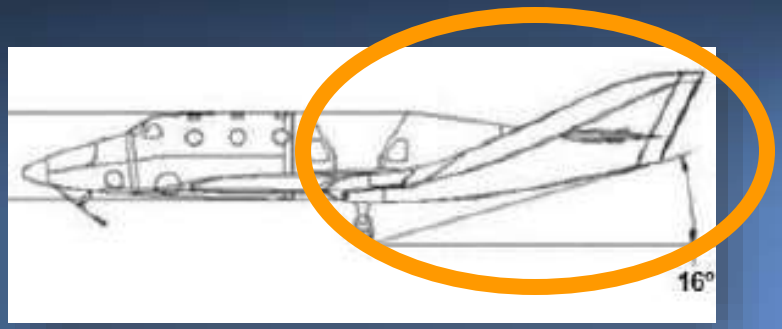
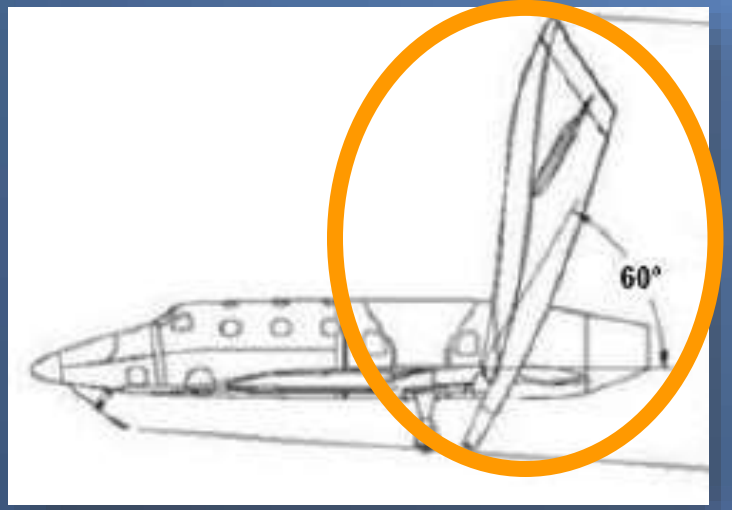

Apogee
Reentry
Boost
Glide
Air Launch
Landing

SpaceShipTwo Feather System



Feather retracted



Feather extended

SpaceShipTwo Flight Deck

Feather extend handle

PROBLEM: During the transonic region, the upward aerodynamic forces acting on the feather exceeded the ability of the feather actuators to keep the feather retracted.

SOLUTION: Provide mechanical locks to keep feather retracted during this region.

Feather Lock Handle

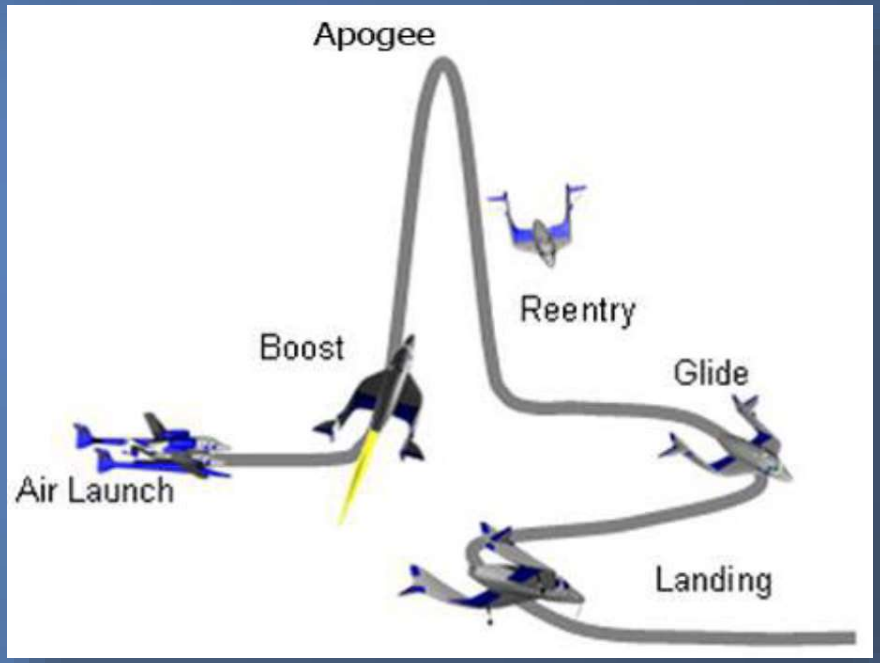
Feather Locked

Lock

Unlock

Feather Unlocked

PROBLEM: If feather could not be unlocked, it would pose a very high risk (probably catastrophic) reentry.



SOLUTION: Unlock feather at 1.4 Mach.

If not unlocked at 1.5 Mach, cockpit alert.

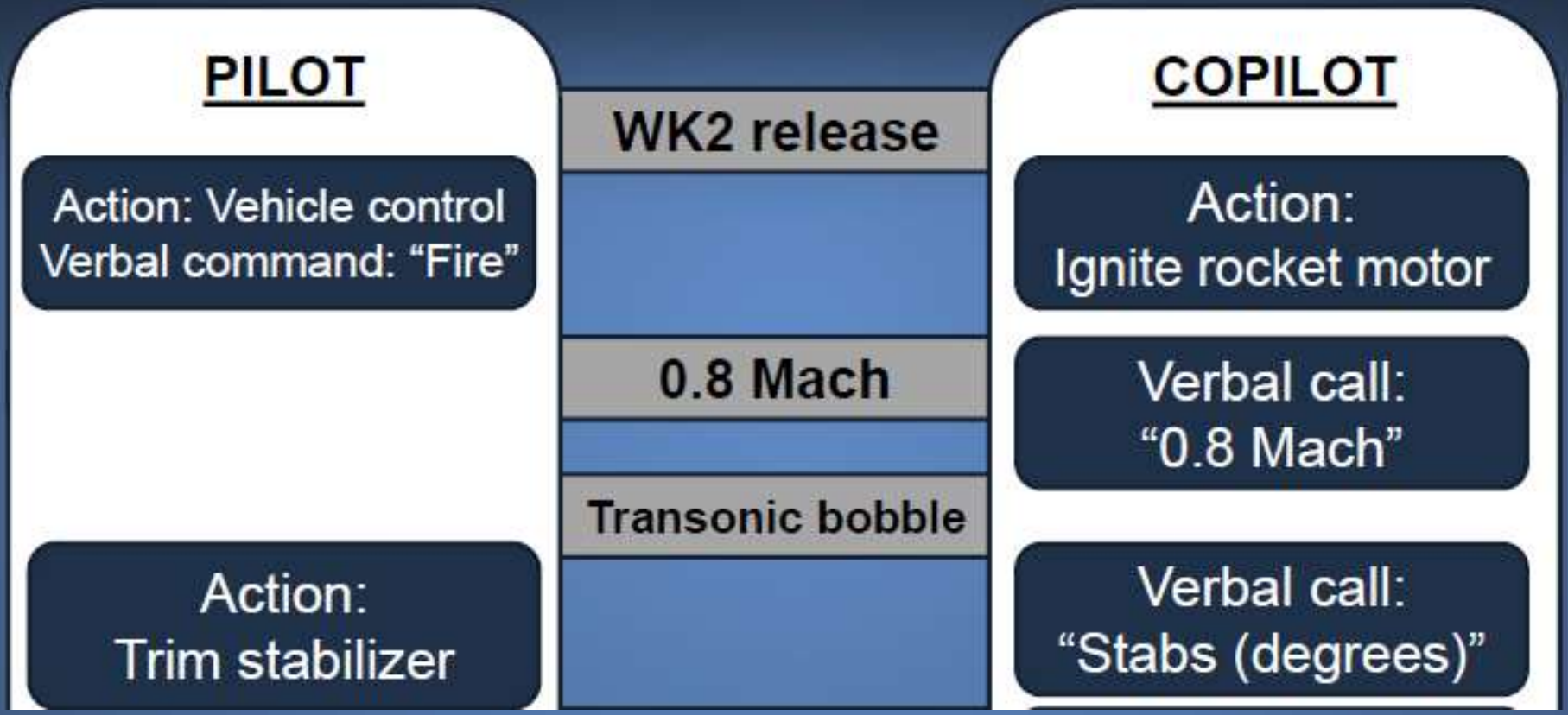
If not unlocked at 1.8 Mach, mission abort.

- High emphasis on making sure feather was unlocked.
  - Cockpit visual and aural alerting
  - Training and procedures
  - Mission abort if not unlocked by 1.8 Mach
- Not great concern placed on low speed unlocking.
  - Relied on pilots to do it right

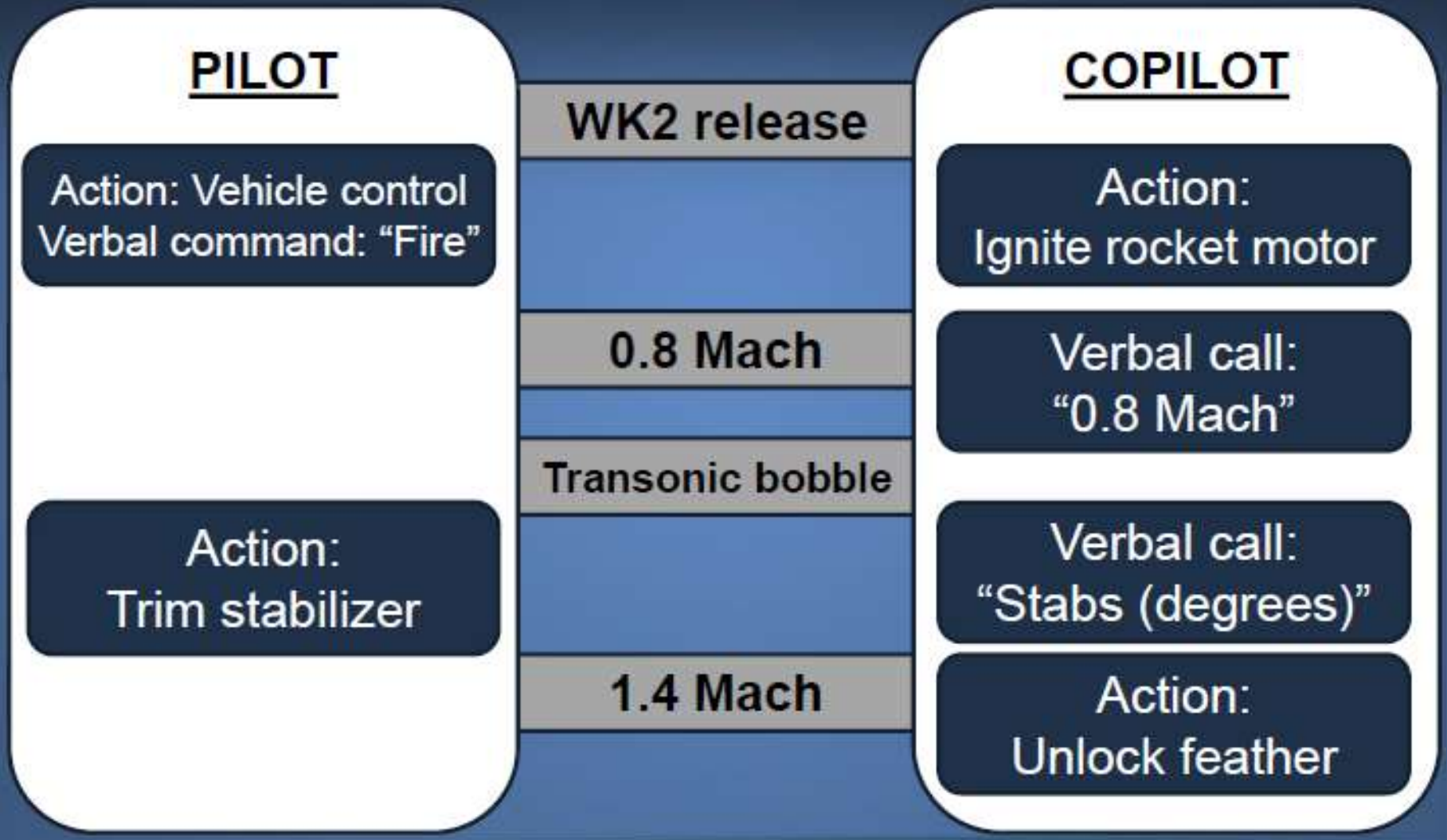
Specified Flight Crew Procedures

Specified Flight Crew Procedures

Specified Flight Crew Procedures



Specified Flight Crew Procedures



What actually occurred

- Copilot made 0.8 Mach callout
- At 0.82 Mach, called out “unlocking” and moved feather handle to unlocked position
- Video and telemetry stopped


Ground-based camera
WhiteKnightTwo camera
SpaceShipTwo camera
galactic

DCA15MA019
SCALED COMPOSITES
SPACESHIPTWO
N339SS
POWERED FLIGHT #4

- A single-point mechanical failure with catastrophic consequences would be unacceptable.
- However, Scaled Composited failed to consider that a single human error could be catastrophic.

NTSB Finding

"By not considering human error as a potential cause of uncommanded feather extension on the SpaceShipTwo vehicle, Scaled Composites missed opportunities to identify the design and/or operational requirements that could have mitigated the consequences of human error during a high workload phase of flight."

Probable Cause of the Accident

- “Scaled Composites’ failure to consider and protect against the possibility that a single human error could result in a catastrophic hazard to the SpaceShipTwo vehicle.
- This failure set the stage for the copilot’s premature unlocking of the feather system as a result of time pressure and vibration and loads that he had not recently experienced, which led to uncommanded feather extension and the subsequent aerodynamic overload and in-flight breakup of the vehicle.”

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